



Related Pending Application

Related Case Serial No: 09/947,355

Related Case Filing Date: 09-07-01

WHAT IS CLAIMED IS:

1. A magnetoresistance effect element comprising:
a magnetization fixed layer in which a direction of magnetization is substantially fixed to one direction;
a magnetization free layer in which a direction of magnetization varies in response to an external magnetic field;
and
a non-magnetic intermediate layer provided between the magnetization fixed layer and the magnetization free layer,
at least one of the magnetization fixed layer and the magnetization free layer having a stacked body in which ferromagnetic layers and non-magnetic layers are alternately stacked,
the non-magnetic layers in the stacked body being thinner than the non-magnetic intermediate layer,
a resistance of the magnetoresistance effect element varying in accordance with a relative angle between the direction of magnetization of the magnetization fixed layer and the direction of magnetization of the magnetization free layer, and
a sense current being flowed to the magnetization fixed layer, the non-magnetic intermediate layer and the magnetization free layer in a direction substantially perpendicular to surfaces of those layers.
2. A magnetoresistance effect element as set forth in claim 1, wherein each of ferromagnetic layers in the stacked body is ferromagnetically coupled.
3. A magnetoresistance effect element as set forth in claim 1, wherein at least one of the ferromagnetic layers included in the stacked body includes a layer of a first ferromagnetic material, and a layer of a second ferromagnetic material different from the first ferromagnetic material.
4. A magnetoresistance effect element as set forth in claim 1, wherein the stacked body includes the ferromagnetic layers of a first ferromagnetic material, and the ferromagnetic layers

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of a second ferromagnetic material different from the first ferromagnetic material.

5. A magnetoresistance effect element as set forth in claim 1, wherein the ferromagnetic layers included in the stacked body contains any one of an iron (Fe) base alloy, a cobalt (Co) base alloy and a nickel (Ni) base alloy, and the non-magnetic layers included in the stacked body contains any one of gold (Au), silver (Ag), copper (Cu), rhodium (Rh), ruthenium (Ru), manganese (Mn), chromium (Cr), rhenium (Re), osmium (Os), iridium (Ir), and an alloy containing any one of gold, silver, copper, rhodium, ruthenium, manganese, chromium, rhenium, osmium, and iridium.

6. A magnetoresistance effect element as set forth in claim 1, wherein at least one of the ferromagnetic layers included in the stacked body contains an iron (Fe) base alloy.

7. A magnetoresistance effect element as set forth in claim 1, wherein each of the magnetization fixed layer and the magnetization free layer has the stacked body, and

the stacking period in the stacked body of the magnetization fixed layer is different from the stacking period in the stacked body of the magnetization free layer.

8. A magnetoresistance effect element as set forth in claim 1, wherein the non-magnetic intermediate layer has a stacked body wherein two kinds or more of non-magnetic layers are stacked.

9. A magnetoresistance effect element as set forth in claim 8, wherein the two kinds or more of non-magnetic layers include two kinds of non-magnetic layers, each of which contains two of gold (Au), silver (Ag), copper (Cu), rhodium (Rh), ruthenium (Ru), manganese (Mn), chromium (Cr), rhenium (Re), osmium (Os), and iridium (Ir) as principal components.

10. A magnetoresistance effect element comprising:
a magnetization fixed layer in which a direction of

magnetization is substantially fixed to one direction;

a magnetization free layer in which a direction of magnetization varies response to an external magnetic field; and

a non-magnetic intermediate layer provided between the magnetization fixed layer and the magnetization free layer,

at least one of the magnetization fixed layer and the magnetization free layer having a stacked body in which two kinds or more of ferromagnetic layers are stacked,

a resistance of the magnetoresistance effect element varying in accordance with a relative angle between the direction of magnetization of the magnetization fixed layer and the direction of magnetization of the magnetization free layer,

a sense current being flowed to the magnetization fixed layer, the non-magnetic intermediate layer and the magnetization free layer in a direction substantially perpendicular to surfaces of those layers.

11. A magnetoresistance effect element as set forth in claim 10, wherein at least one of the ferromagnetic layers included in the stacked body contains an iron (Fe) base alloy.

12. A magnetoresistance effect element as set forth in claim 10, wherein at least one of the ferromagnetic layers included in the stacked body is formed of an alloy containing nickel (Ni), iron (Fe) or cobalt (Co).

13. A magnetoresistance effect element as set forth in claim 10, wherein the stacked body is any one of an (NiFe alloy / CoFe alloy) stacked body, an (Fe base alloy / NiFe alloy) stacked body, and an (Fe base alloy / CoFe alloy) stacked body.

14. A magnetoresistance effect element as set forth in claim 10, wherein each of the magnetization fixed layer and the magnetization free layer has the stacked body, and

the stacking period in the stacked body of the magnetization fixed layer is different from the stacking period in the stacked body of the magnetization free layer.

15. A magnetoresistance effect element as set forth in claim 10, wherein the non-magnetic intermediate layer has a stacked body wherein two kinds or more of non-magnetic layers are stacked.

16. A magnetoresistance effect element as set forth in claim 15, wherein the two kinds or more of non-magnetic layers include two kinds of non-magnetic layers, each of which contains two of gold (Au), silver (Ag) and copper (Cu) as principal components.

17. A magnetic head having a magnetoresistance effect element as set forth in claim 1.

18. A magnetic head having a magnetoresistance effect element as set forth in claim 10.

19. A magnetic recording and/or reproducing system which has a magnetic head as set forth in claim 17 and which is capable of reading magnetic information stored in a magnetic recording medium.

20. A magnetic recording and/or reproducing system which has a magnetic head as set forth in claim 18 and which is capable of reading magnetic information stored in a magnetic recording medium.

ABSTRACT OF THE DISCLOSURE

There is provided a practical magnetoresistance effect element which has an appropriate value of resistance, which can be sensitized and which has a small number of magnetic layers to be controlled, and a magnetic head and magnetic recording and/or reproducing system using the same. In a magnetoresistance effect element wherein a sense current is caused to flow in a direction perpendicular to the plane of the film, if a pinned layer and a free layer have a stacked construction of a magnetic layer and a non-magnetic layer or a stacked construction of a magnetic layer and a magnetic layer, it is possible to provide a practical magnetoresistance effect element which has an appropriate value of resistance, which can be sensitized and which has a small number of magnetic layers, while effectively utilizing the scattering effect depending on spin.

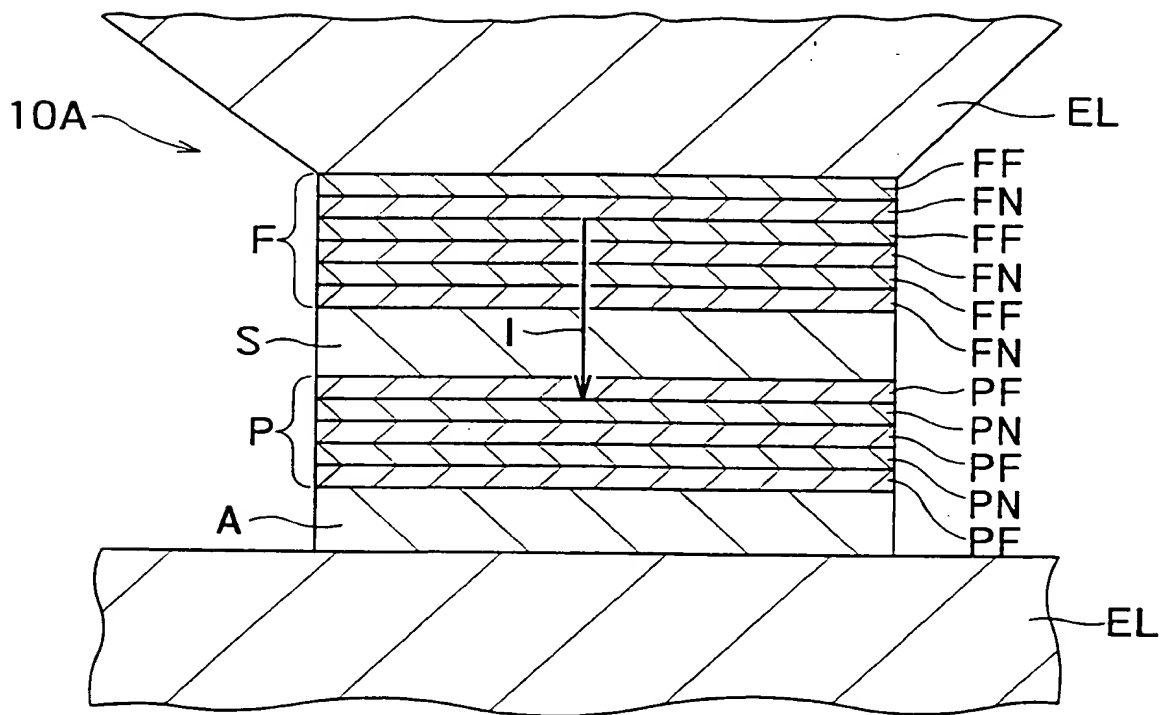


FIG. 1

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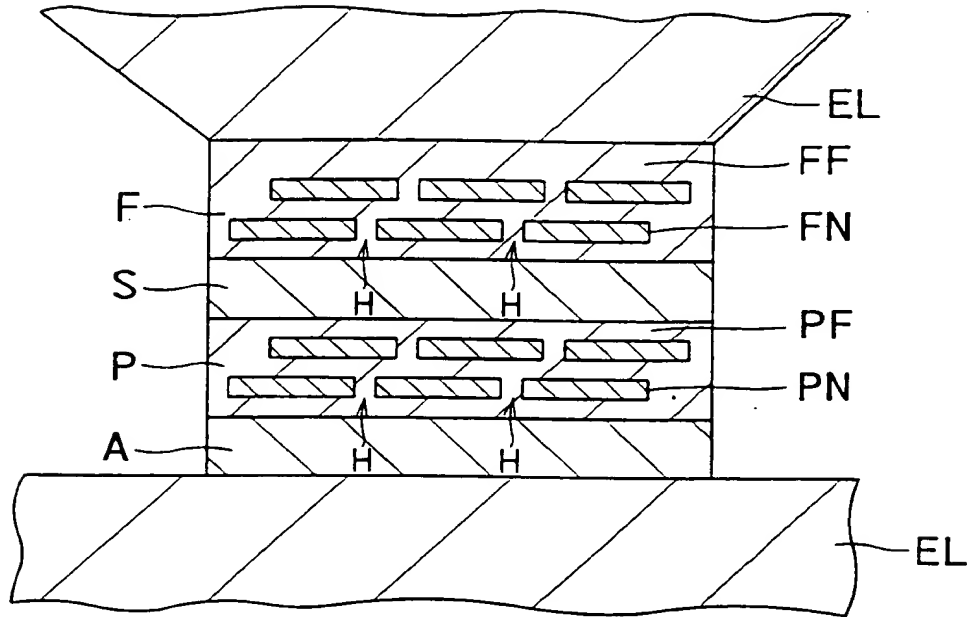


FIG. 2

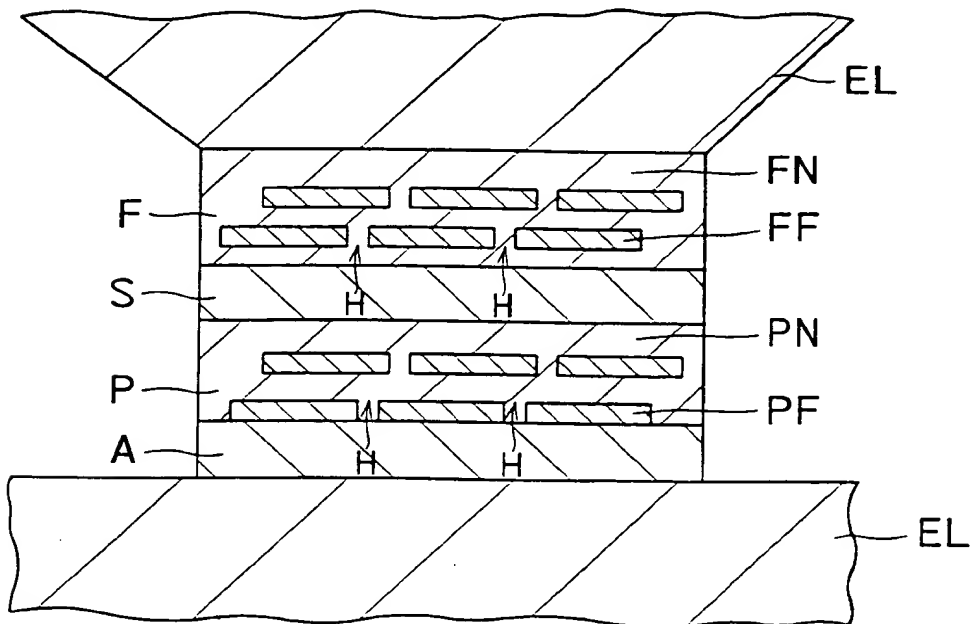


FIG. 3

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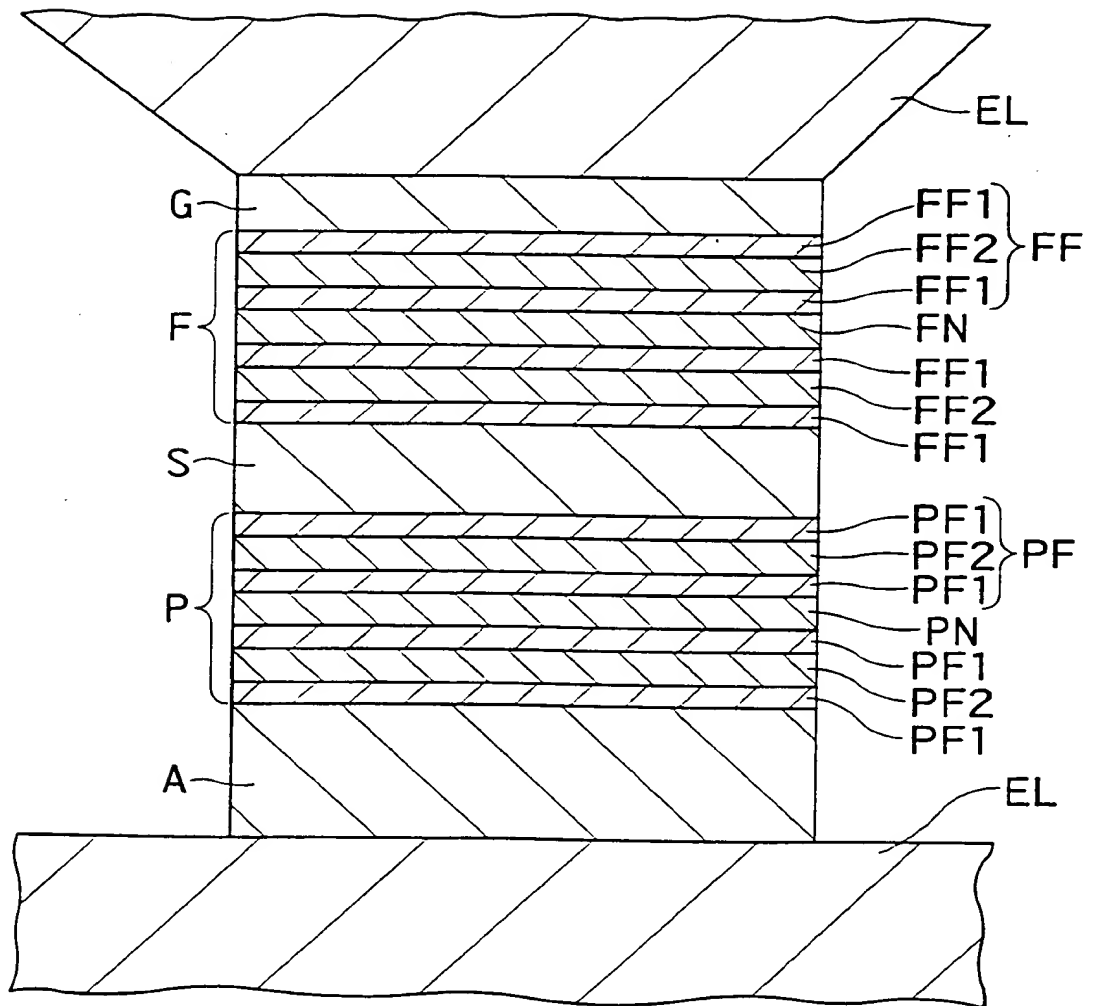


FIG. 4

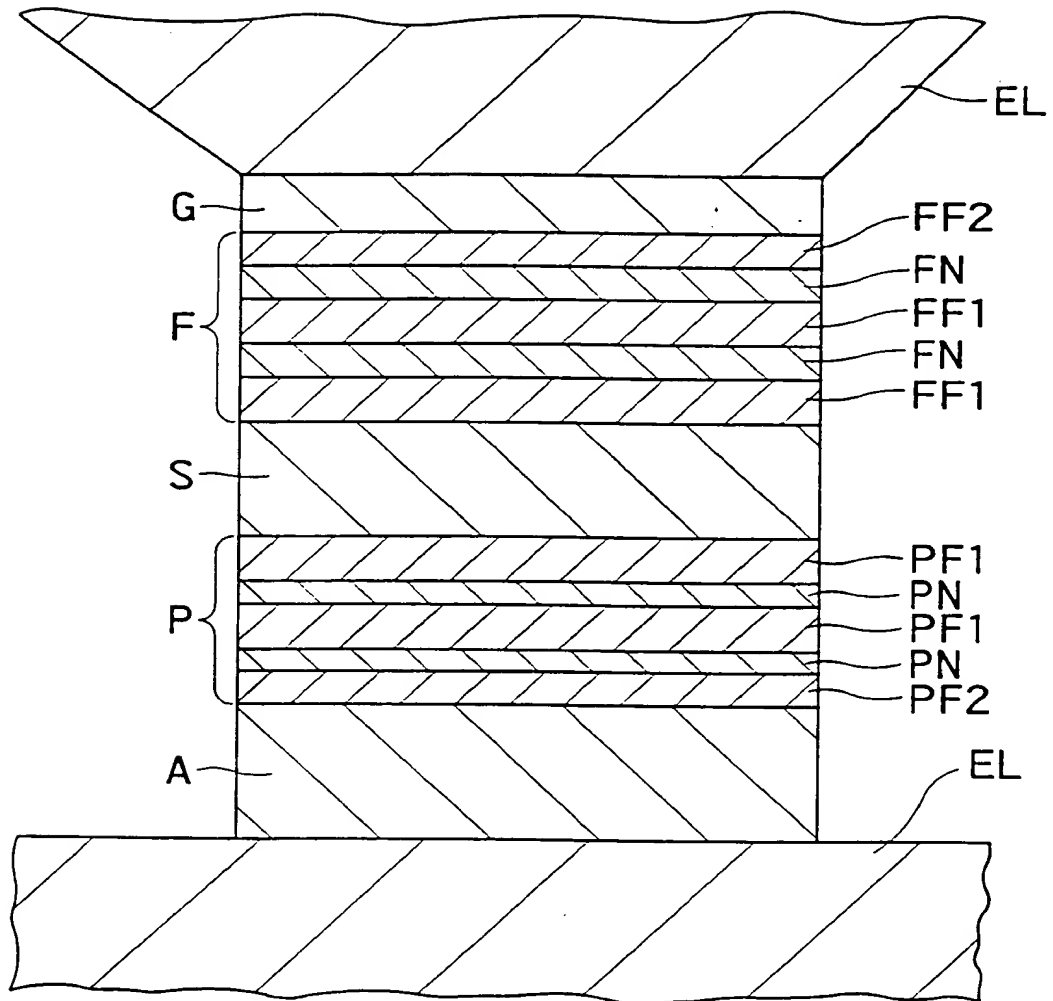


FIG. 5

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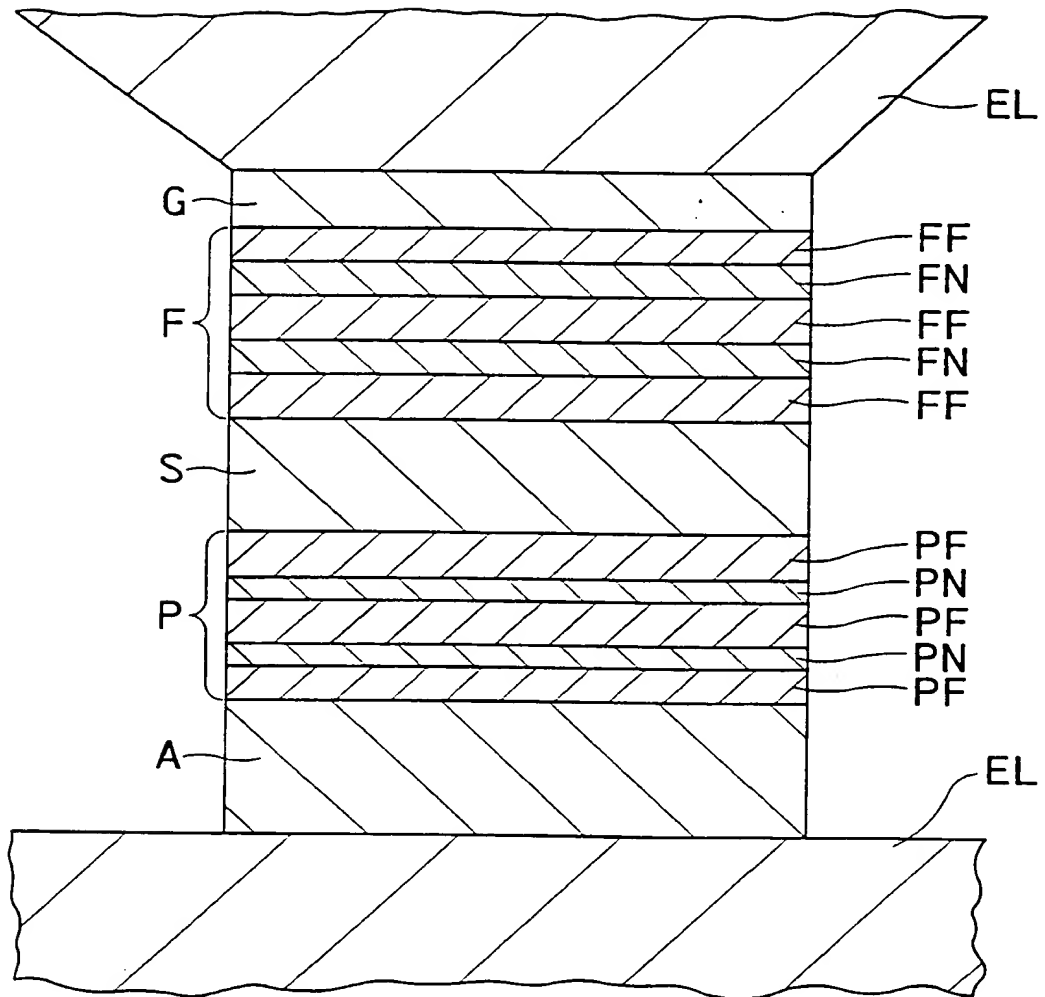
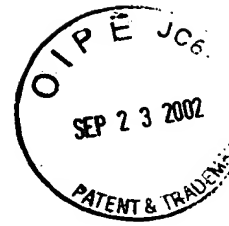


FIG. 6

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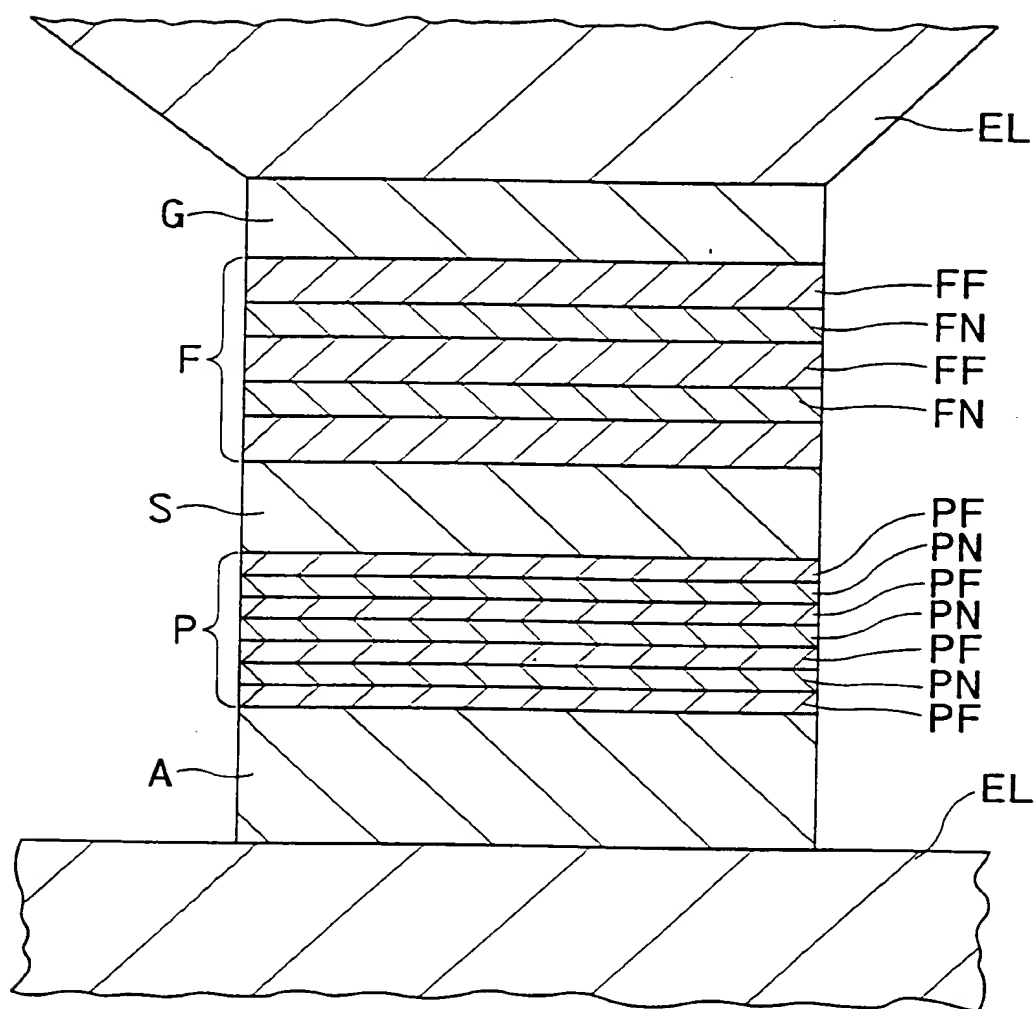
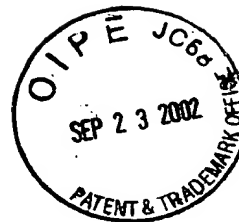


FIG. 7

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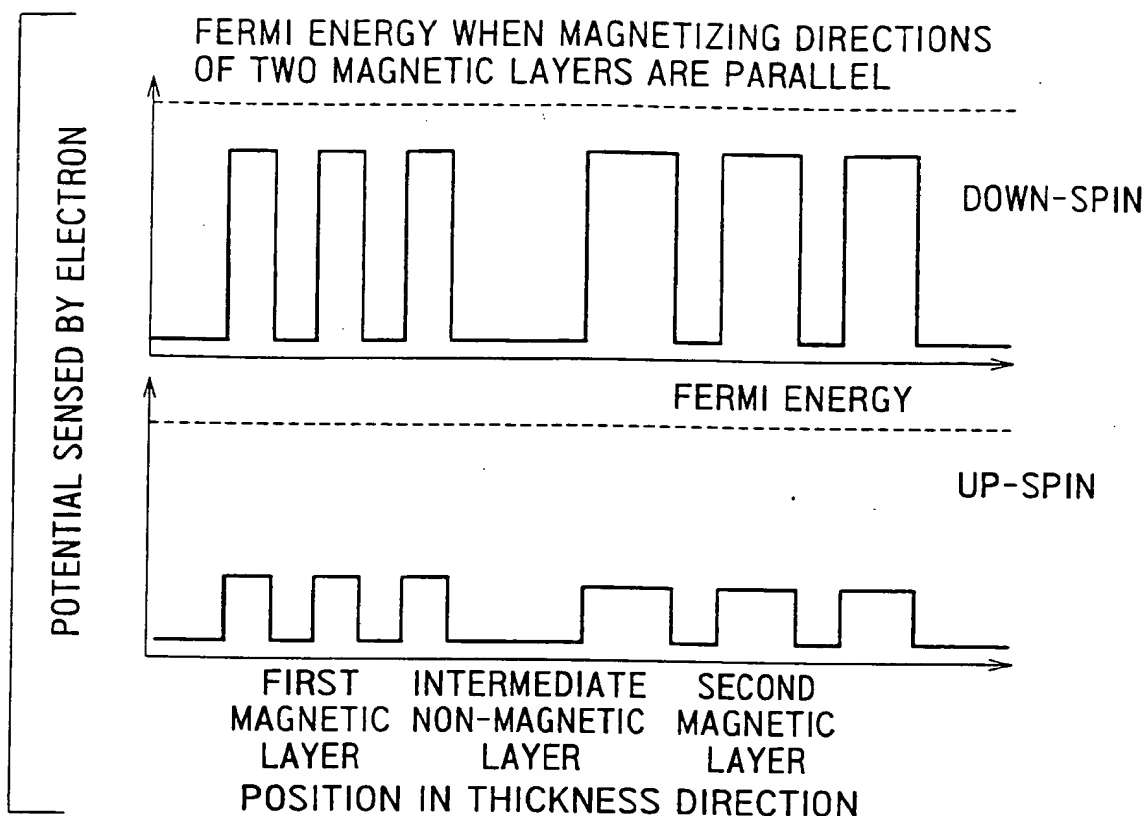


FIG. 8A

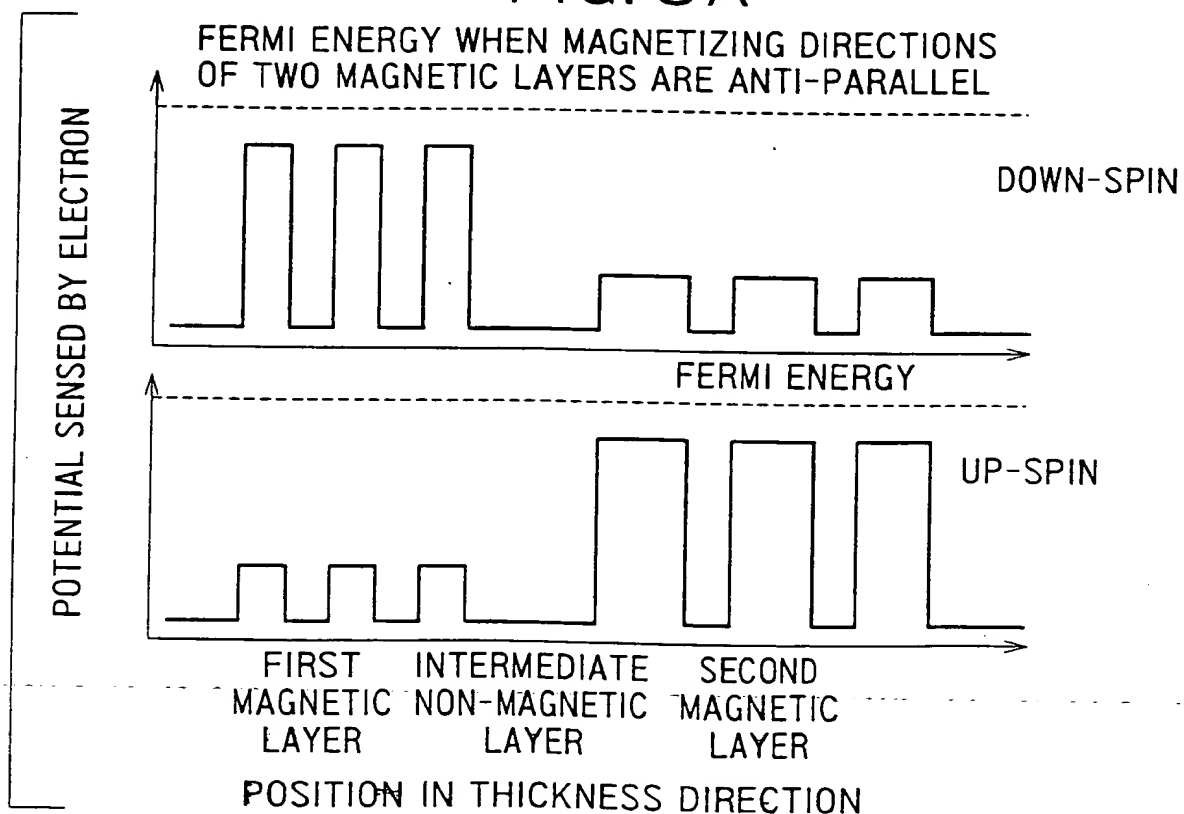


FIG. 8B

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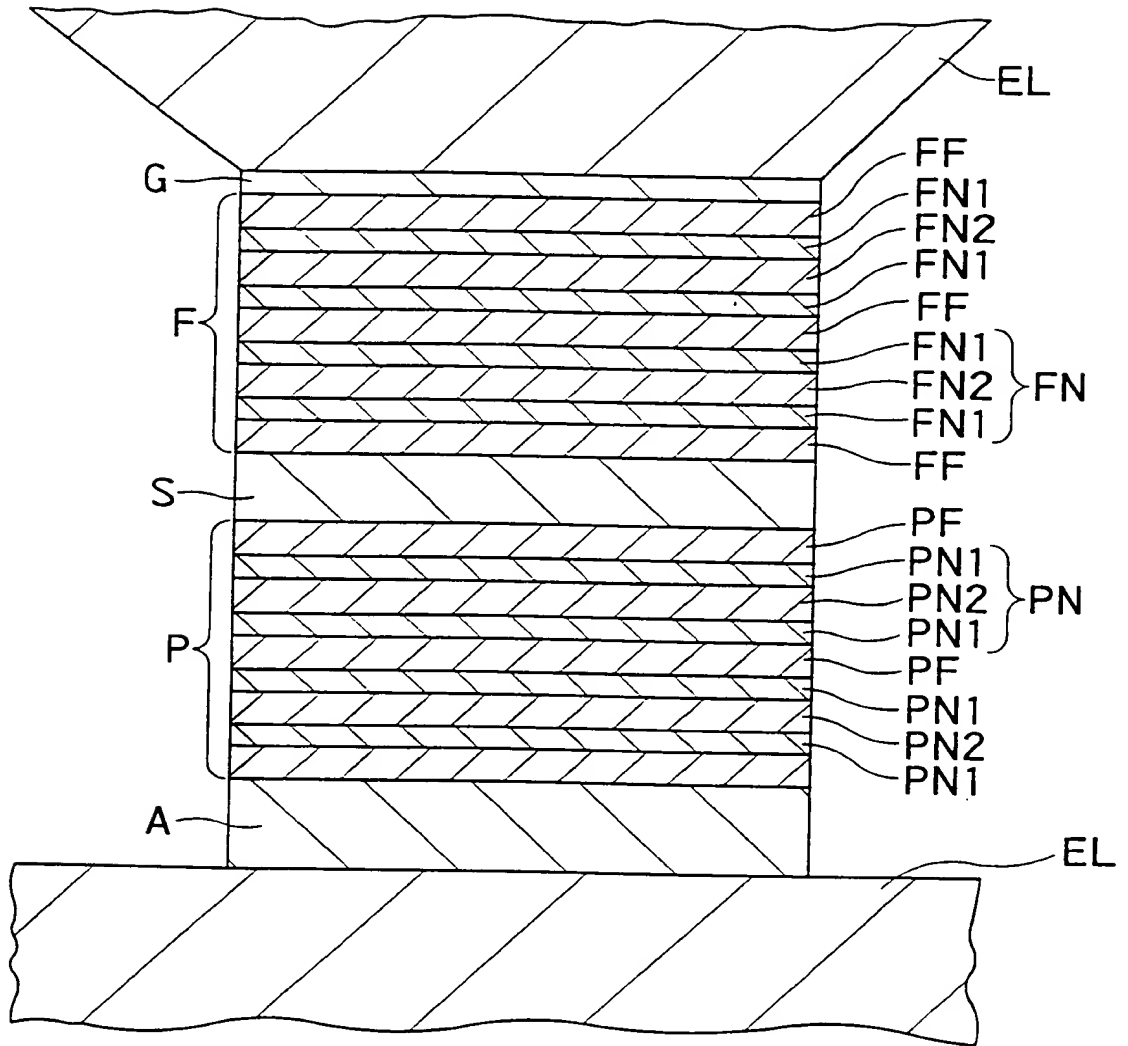


FIG. 9

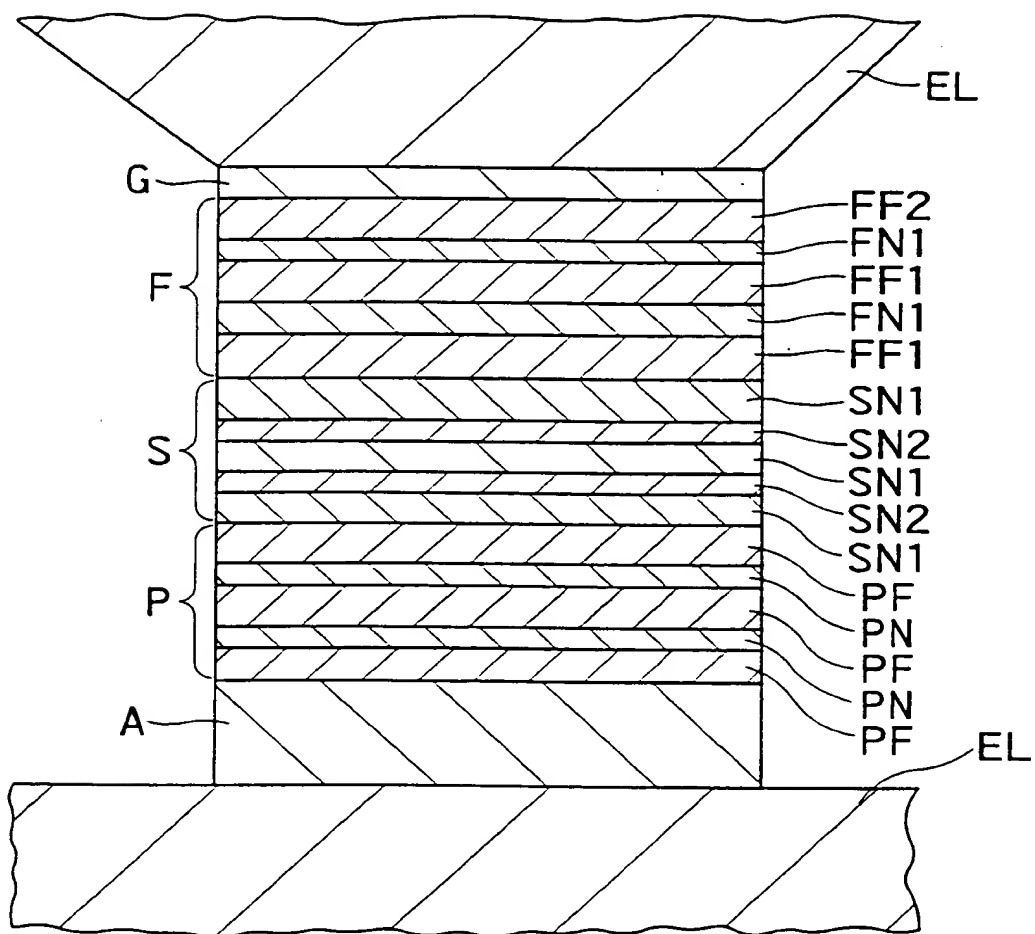


FIG. 10



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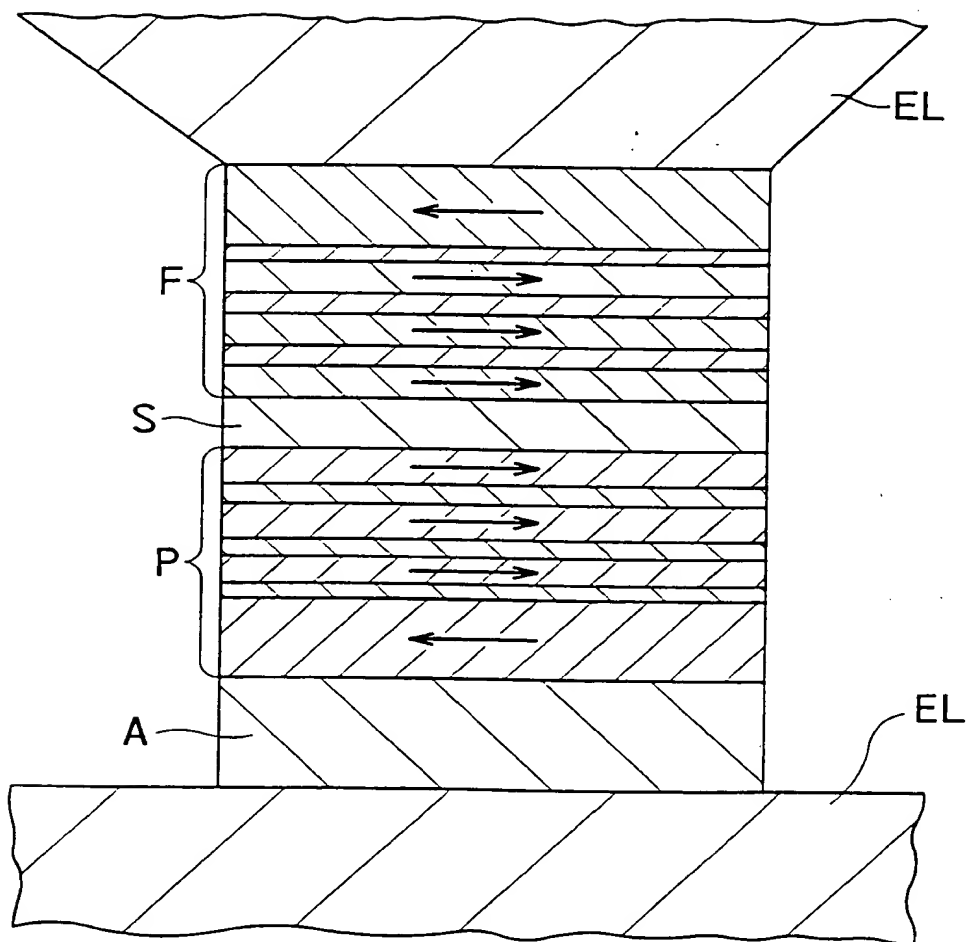
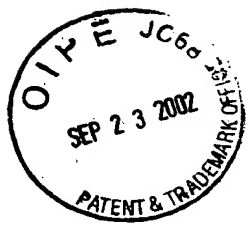


FIG. 11



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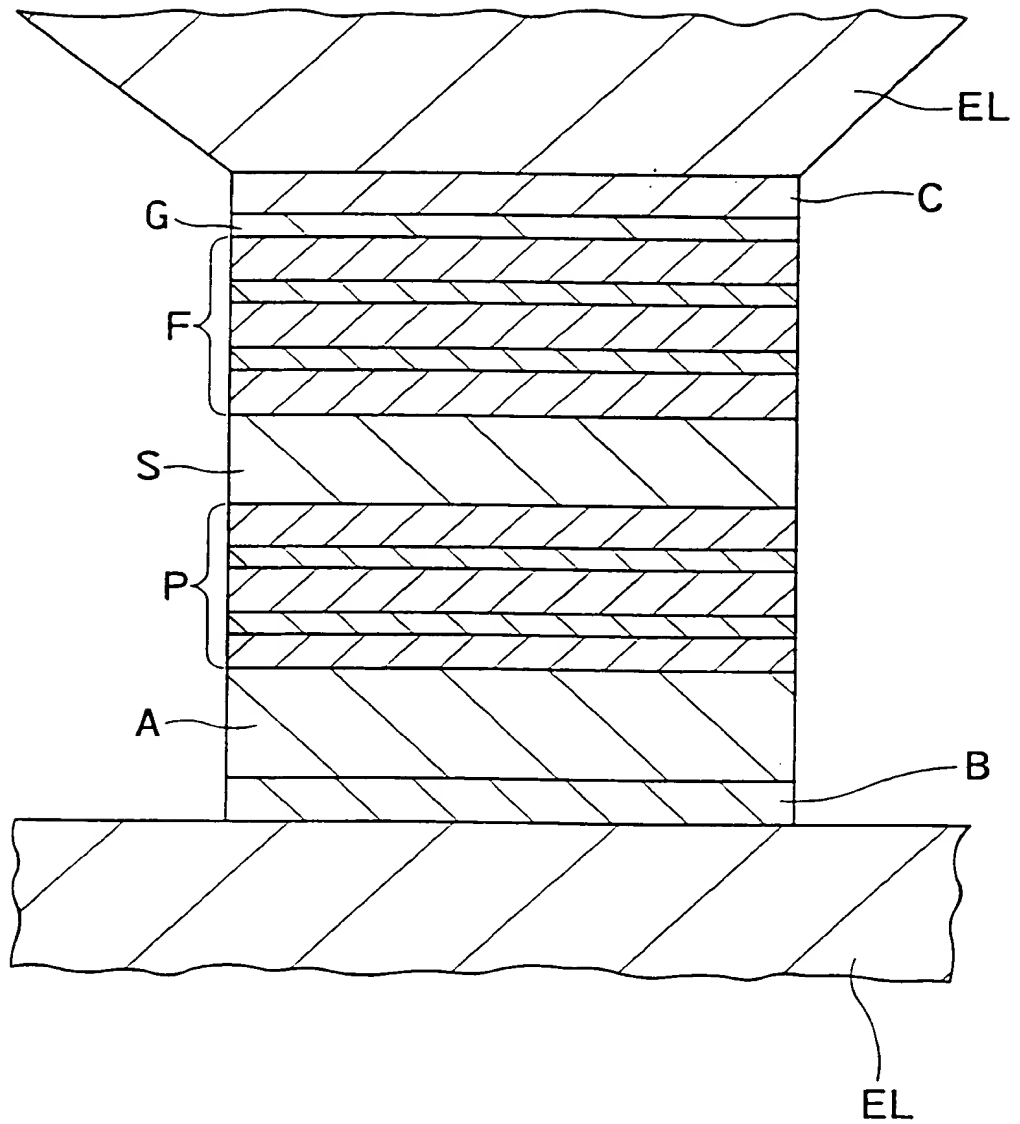


FIG. 12



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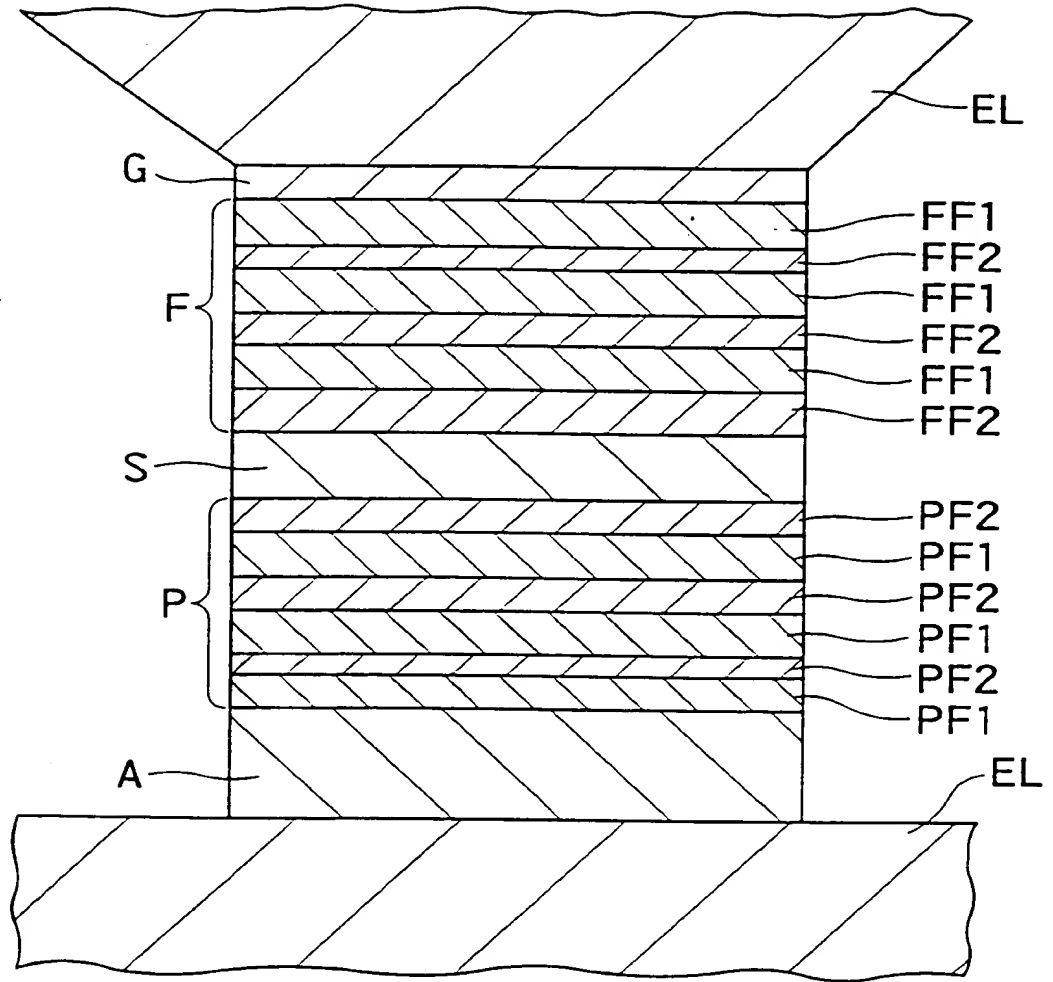


FIG. 13

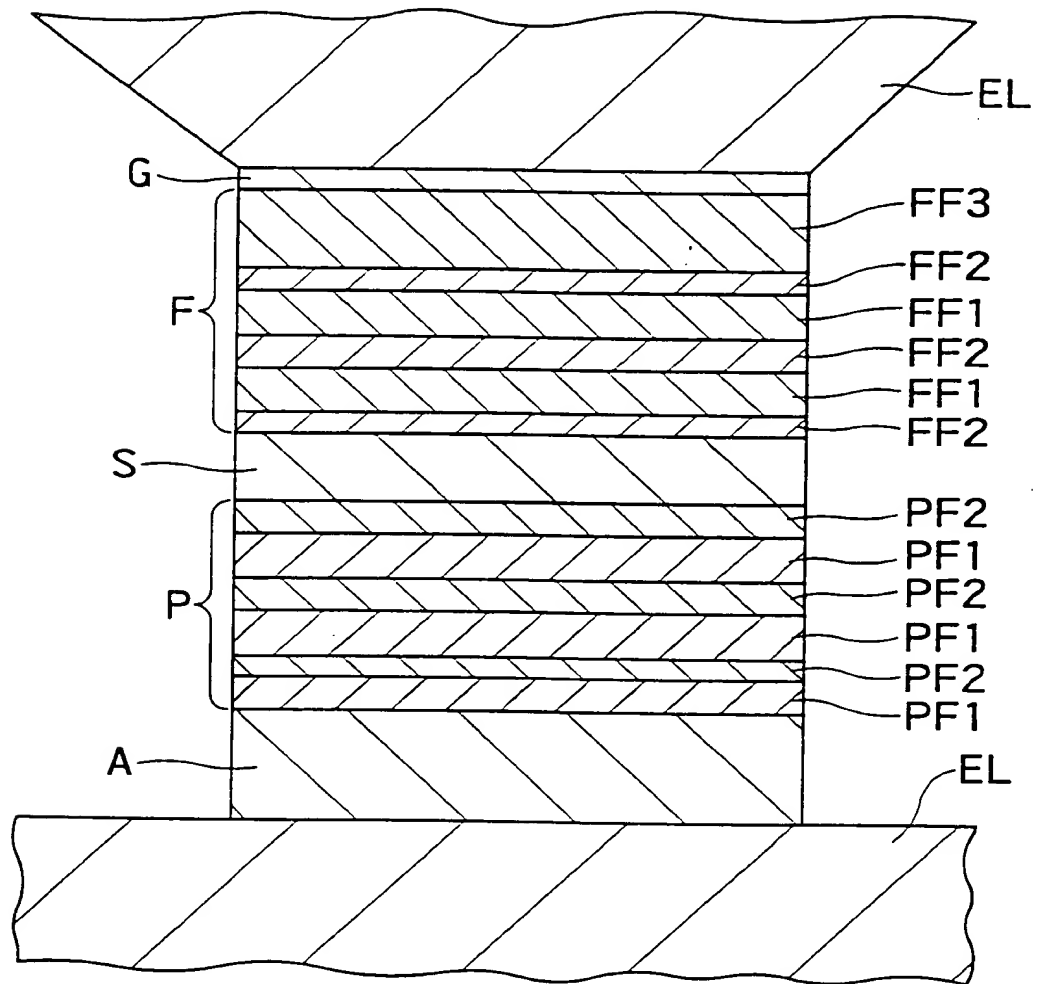


FIG. 14

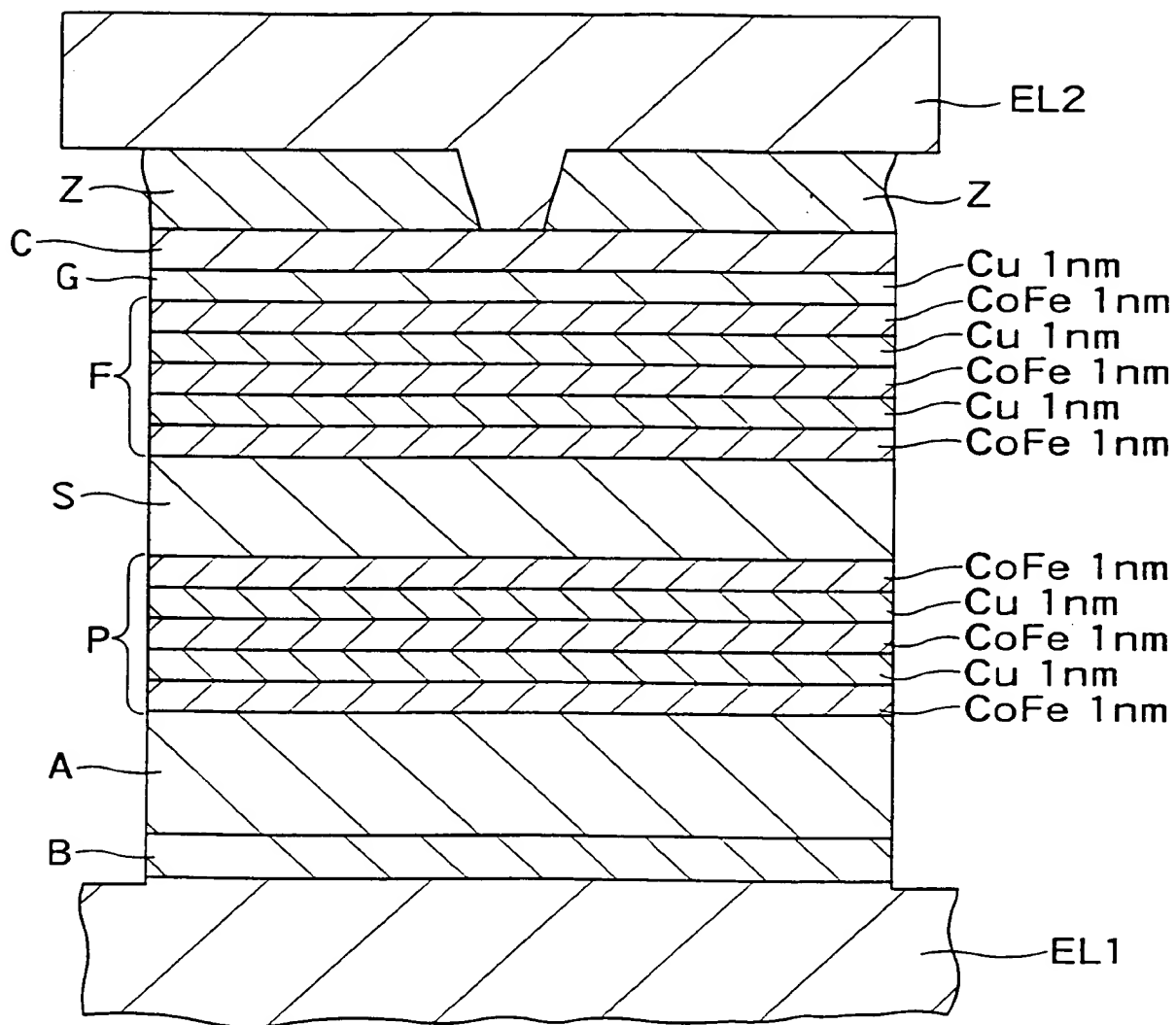


FIG. 15

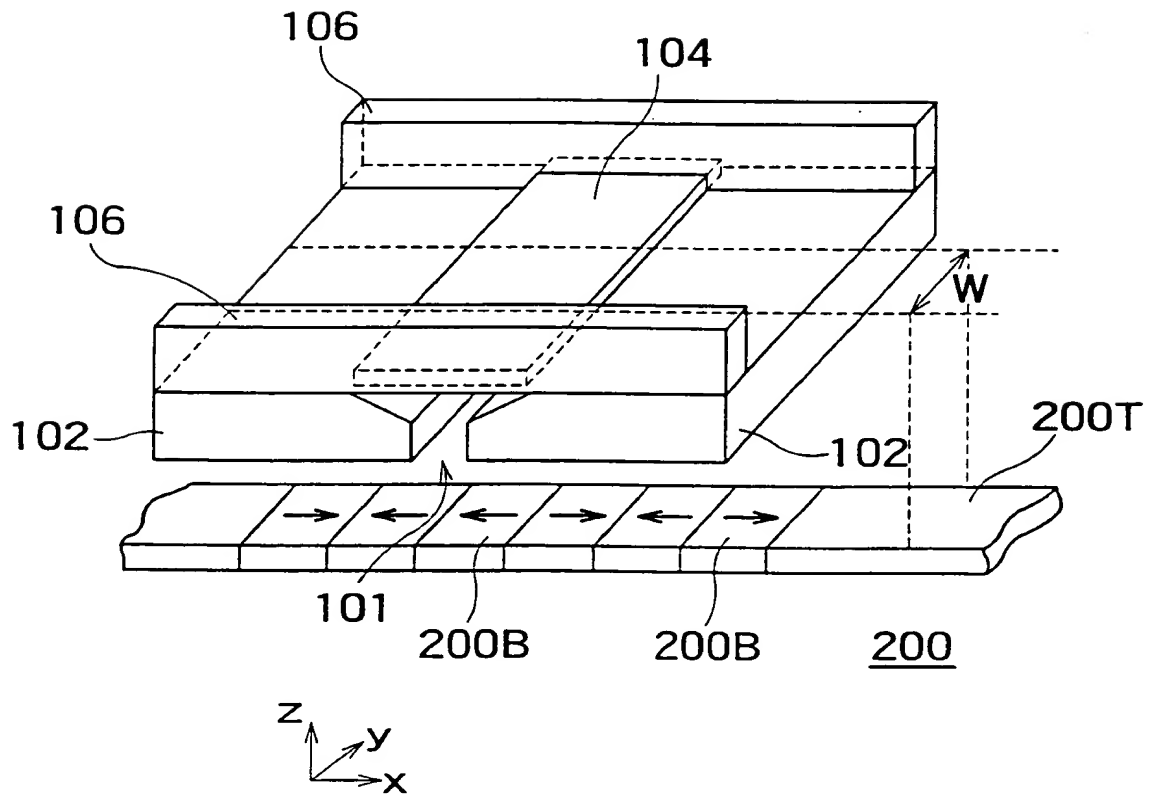
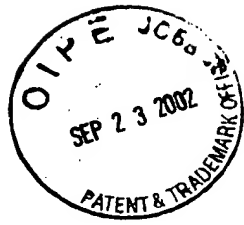


FIG. 16



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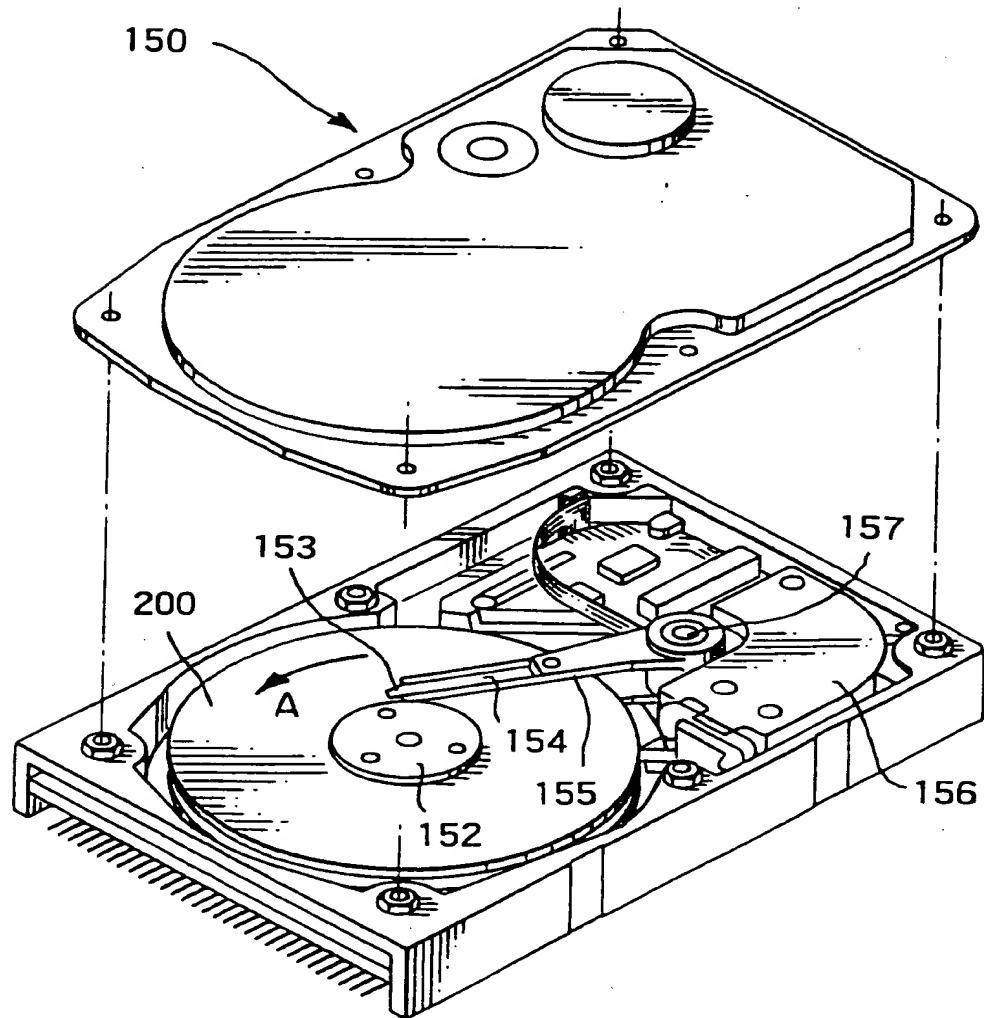
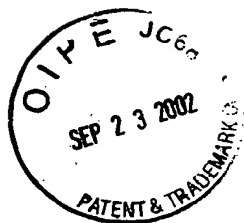


FIG. 17



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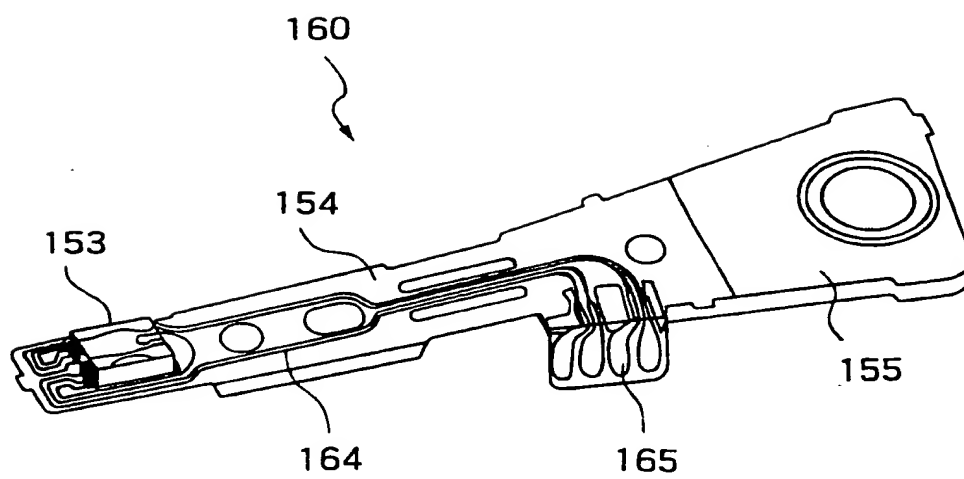
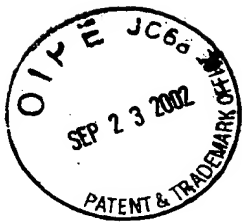


FIG. 18



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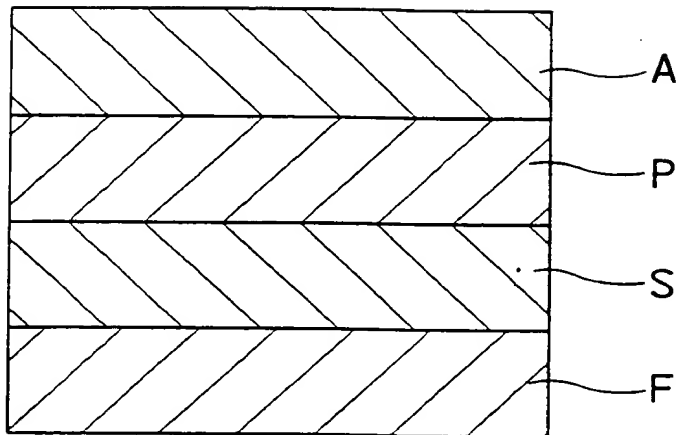


FIG. 19

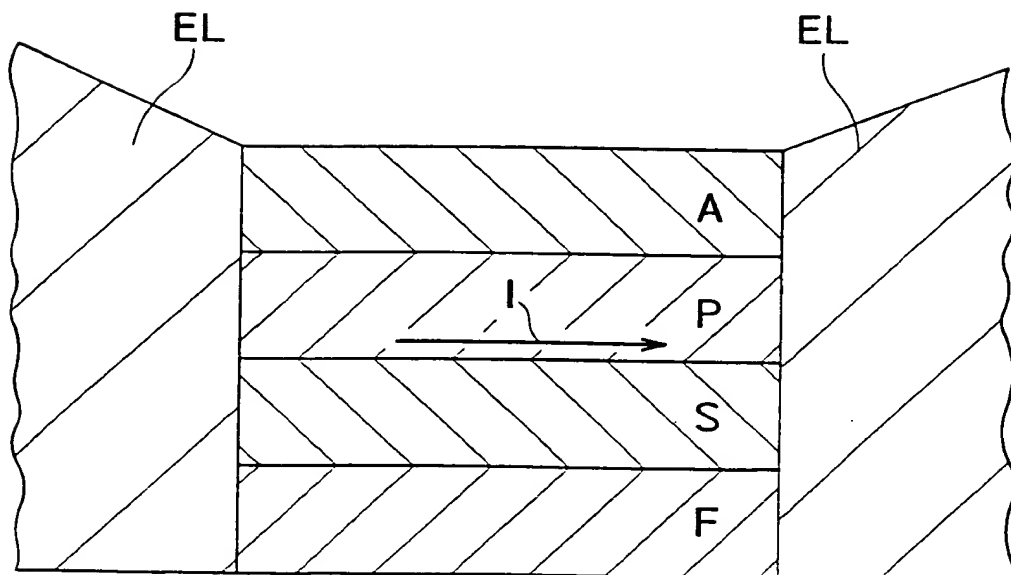
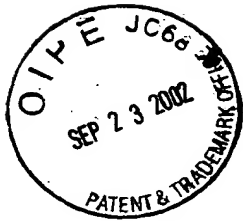


FIG. 20



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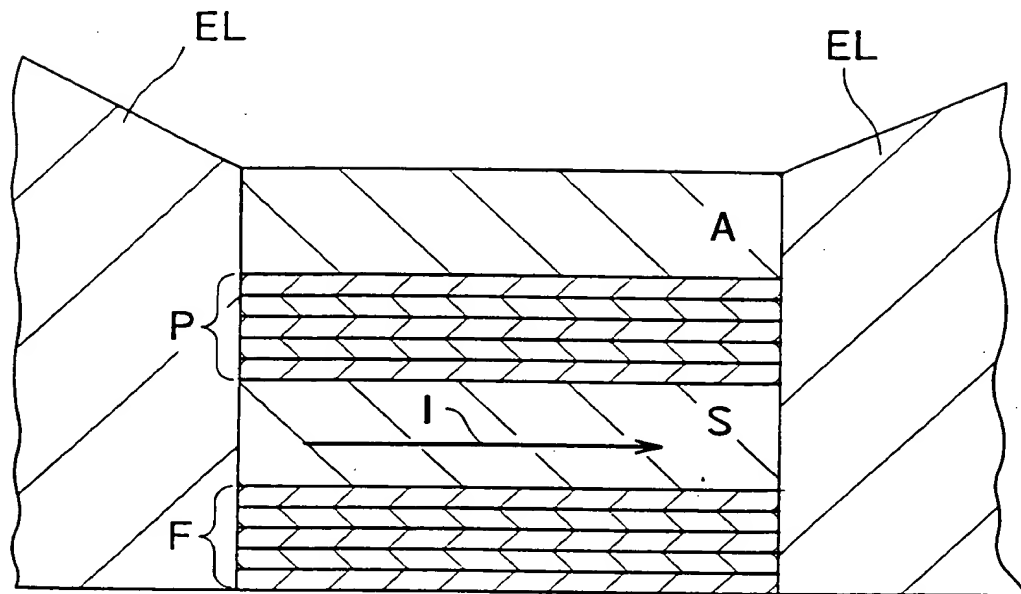


FIG. 21

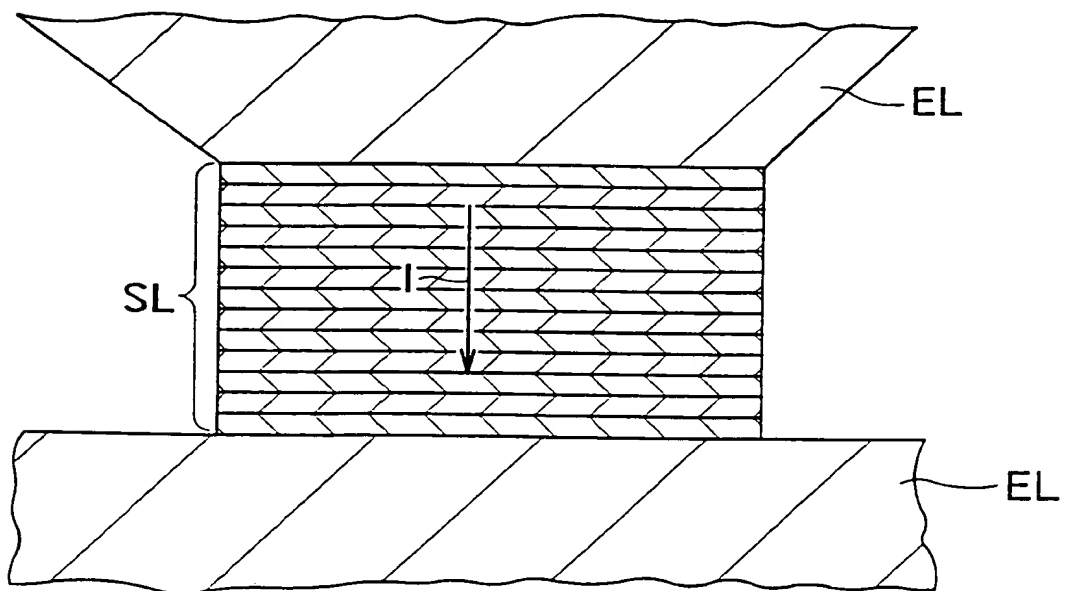
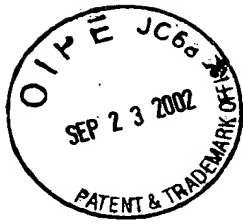


FIG. 22



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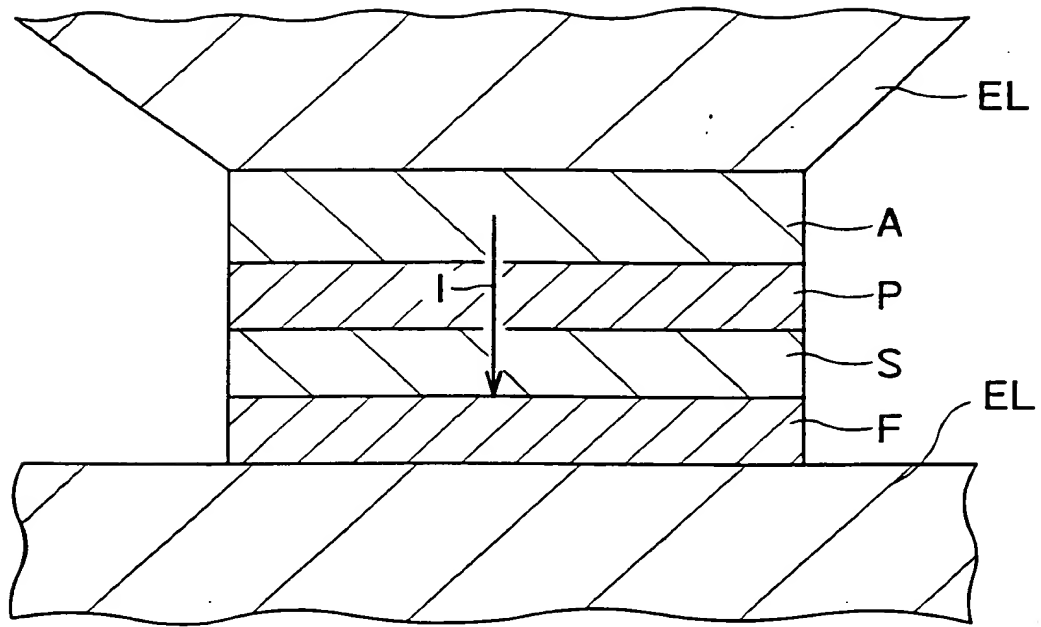


FIG. 23

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